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ORGANIZED KNOWLEDGE AND NATIONAL WELFARE[1]

THE future of any nation is secure if it lives up to its possibilities. The nation which does this is bound to be a leader among nations and to command world-wide respect. Its national problems will be solved and solved intelligently and thoroughly. The greatness of a man is in part born in him and in part the product of his environment. According to eminent biologists, he is about two fifths born and three fifths made. Similarly, a nation is great according to its resources and according to its development of these resources. And the development of those resources may be accomplished only through organized knowledge.

I. *The Function of Organized Knowledge.*—Consider for a moment two manufacturing concerns on an equal footing as regards output, but of which one is continually making progress through improvements in manufacturing processes, developing new and valuable products and investigating the fundamental principles underlying all these processes. This firm will in time outstrip the other in every way; the balance, in fact, is a very delicate one, since the results are cumulative. In quite a similar manner, that nation will advance to leadership in which the increase in organized knowledge and the application of that knowledge are greatest. For this reason, interest in research should be as wide as the nation and should cover the

[1] Abstract of an address given April 9, 1917, to the Associated Engineering Societies of Worcester.

whole gamut of problems from administration to agriculture, from medicine to manufacture. For it is only through the solution of individual problems that general principles can be arrived at and the sum total of useful organized knowledge increased.

It is essential that the wide field to be covered be kept in mind, extending over not only physics, chemistry, engineering and all their branches, but all the biological and mental sciences as well. In the last analysis an increase in knowledge in the field of the *biological sciences* means more and better food, improved racial stock and improved public health as well as increased material welfare in all having to do with plants and animals. Increased knowledge of the fundamental principles of the *mental sciences* means increased efficiency in administration, legislation, education, operation and research. I do not mean mere book learning in psychology, but such a command of the fundamental principles as will assist in the solution of all practical problems. Increased knowledge of *chemistry* means increased ability to utilize raw materials and an improvement in general health and living conditions. One may almost say that the generalized problem of chemistry is to convert the less expensive raw materials such as cellulose, petroleum, glucose, various minerals and oils, starch, nitrogen of the air and the like into food, clothing, tools for our use and means for national defense. An application of the fundamental principles of *physics* in the way of various engineering problems leads to a fuller utilization of resources, new products useful to man, makes inventions possible and effective and adds to the general increase in operating efficiency in every way.

The utilization of organized knowledge in national welfare comes about both through knowledge itself and the incentive to apply that knowledge. Both ability and incentive are essential to utilization. So far as knowledge went, we might have made dyes and optical glass many years ago in this country, but since they could be bought so cheaply there was no incentive to develop the manufacture of such articles. These are cases of ability without incentive. On the other hand, there has long been an incentive for the fixation of nitrogen and for various mechanical devices, but these have not been forthcoming for lack of sufficient knowledge.

The incentive to do our best, to live up to our possibilities as a nation or as individuals may be classed as either psychic or commercial. In the last analysis, the tendency towards doing our best is hardly more than a rudimentary instinct. The commercial incentive is a matter of either supplying our direct needs or supplying some one else's needs for a consideration. The psychic incentives to put forth our best efforts may be classed under the heads of emulation, contact, contract and struggle for existence. A great many students enter research because their favorite professors have made reputations in research or because their friends and colleagues are doing such work. Incentive by *contact* covers the psychology of getting started at the line of work you wish to become interested in. It is well known that the work itself produces a reaction on one's mind which makes it much easier to continue the work. Exactly, this form of stimulus is experienced in writing a scientific paper, for example. Incentive by *contract* to put forth our best efforts comes from putting ourselves under obligation to produce certain results. The substance of this lecture has been in my mind for many years, but it would never have been prepared but for my having undertaken to talk on this sub-

ject. This is a typical example of polarization by contract. Finally, the incentive of stern necessity or what we consider necessity is perhaps the most powerful of all in both research and application. All who have families to support and needs to be supplied know full well the stimulus which comes from them.

In general, in normal times it is perhaps no exaggeration to say that neither the average individual nor the average nation approaches within fifty per cent. of its possibilities. Nothing short of a war threatening the national existence can shake a nation out of its lethargy. Similarly, the average individual can not be induced to put forth his best efforts without the strongest of incentives. It is unfortunate that this is the case. However, with sufficient attention given to the problem by trained experts in mental science, it is quite possible that at some future date as high as sixty or eighty per cent. of the possibilites may be realized without any appeal to arms for the nation or any unusual incentive for the individual.

II. *The Increase of Organized Knowledge.*—The research by which organized knowledge is increased will doubtless always be carried on chiefly by three distinct types of research organizations: research by the government in national laboratories, research by the universities in connection with the work of instruction and research by industrial laboratories in connection with the interests of manufacturing concerns. Aside from these three main classes of laboratories there will always be large, privately endowed research organizations, dealing with neglected fields of remote commercial interest, private industrial laboratories supported by consulting fees and cooperative testing laboratories also self sustaining.

National, industrial and university research follow three essentially different lines. There is considerable overlap in field, it is true, but each is centered on a different kind of research. The proper function of national research is the solution of such problems as concern the nation as a whole, affect the general interests of all classes of individuals; it is the custodian of standards, it develops methods of precise measurements and investigation, it is trouble engineer for the solution of very difficult problems or the problems of producing units so small as not to be able to have their own research laboratories. It is the proper guardian of the public health. It solves problems connected with contagious and vocational diseases. It develops methods of making good roads, increasing the fertility of the soil and stocking waters with fish. National research is of all grades from that dealing with fundamental principles up to that relating merely to lessening the costs of production.

University research must always, in the very nature of things, be concerned chiefly with the advancement of the various sciences as such, and with the development of the fundamental principles of each science. The best university instruction is along these lines and investigators and students in close touch with them will naturally have most new ideas in close connection with fundamental principles. University research is necessarily one of small jobs and the best minds and is without very much continuity. The advanced student is interested in a research just long enough to make it acceptable as a doctor's thesis. The instructor is too burdened with teaching to give more than a margin of time to research. But a very small part of the university research is extended year after year covering a wide field. This is quite as it should be, the university looking after those

fields of research of little commercial value, on the one hand, and not directly affecting the interests of the nation as a whole, on the other, but of fundamental and far reaching importance to all.

Industrial research takes the middle ground and has already become a distinct profession. It is in close touch with practical commercial application, on the one hand, and with fundamental principles, on the other. Its proper field is anything between elimination of works troubles and the investigation of fundamental principles. The staff of the ideal industrial research laboratory is composed of experts of wide experience who can serve the manufacturing departments in a consulting capacity without sacrifice of time. We may perhaps best summarize the preceding statements by describing the ideal research man and the ideal research laboratory.

Some writers have spoken of the investigator as a rare individual to be sifted out from educational institutions with great care for a particular line of work. My personal opinion is that a large percentage of the men students are fitted for research work if properly started along the right line. The investigator should have a mind at once fertile and well trained. His mind should be teeming with new ideas, but he should possess unerring judgment to reject those which are not logical or promising. We are often asked what sort of preparation in physics would be best for men intending to take up research as a life work. It has even been proposed to give courses in "applied physics" for the benefit of those intending to take up industrial research. Our invariable reply is that the best preparation for a research man is a thorough grounding in the fundamental principles of his science: physics, chemistry or whatever it may be. If he has this thorough knowledge of fundamental principles it is safe to say that in any properly organized research laboratory with the proper leadership and companions, such a student will have many times as many useful ideas as he can himself possibly follow up with research. Hardly any one who has completed advanced work in a science can read, say an abstract journal, without thinking of many problems which he would like to investigate. Fertility of mind is not so much an inborn quality of the mind itself as of the training and association which that mind has had.

The ideal industrial research organization may perhaps be outlined with a knowledge of its development during the last fifteen years. I shall give, frankly, my personal views in the matter, based on an intimate knowledge of four universities, three professional research laboratories and a visiting acquaintance, so to speak, with quite a number of others. The ideal industrial laboratory, in my mind, consists of two quite distinct divisions: one taking the brunt of works troubles and testing or making analyses of the material used. The other wing is complementary to this and deals with the larger fundamental problems encountered, problems requiring skilled specialists and considerable time for their solution. The alternative organization with a single research laboratory covering both works troubles and fundamental problems is not so successful. The plan in this case is to have considerable research in progress of very little interest to the company, but engaging a staff much larger than required to take care of ordinary works troubles. In this case, when works troubles are many and insistent, as they are wont to be at times, the staff engaged upon fundamental research forms a reserve to be called out occasionally to deal with works troubles. The disadvantages of this are that the fundamental work is subject to more or less frequent interruption and can not be so efficiently carried on. On the other hand,

when the research is in two quite distinct divisions, fundamental work is not subject to interruption by works troubles.

Industrial research is preeminently fitted to be carried on by team work. This we have developed to a high degree in Pittsburgh and consider very much more efficient than the alternative cell system where each leading man has a room or suite of rooms to himself and keeps his work to himself. In the ideal organization, two or three men work together on the same large problem or group of problems, the aim being to have a good theoretical man and a good experimentalist working together as much as possible or even a physicist and chemist in some cases. The characteristic of the team work plan, however, is the conference system. The five or six men most interested in each line of research meet for an hour each week to discuss the problem in its various aspects, to plan new work and to consider various interpretations and applications of the results obtained. The ideal conference is not less than four and not more than eight men and includes an efficient stenographer. To one experienced in such team work, the results of getting together are surprising. A good suggestion is no sooner made than capped by a better and the saving in time and effort is almost incalculable.

The conference system also aids in putting useful results before the other wing of the research division and before the patent department. At each of our conferences are representatives of the other wing of the research division, charged with taking up any results immediately applicable, and a member of the legal department who takes care of any ideas worth patenting. This plan of conferences relieves the scientific men from responsibility for calling the attention of the works or of the patent department to useful patentable results.

So far as national welfare is concerned, in order to increase our stock of organized knowledge, we need more teaching by professors and instructors in closer touch with industrial problems. So far as developing research men goes, the ideal instructor is probably an ex-professional research man and, in many cases, one who has made a reputation or a fortune by his work along industrial lines. Another need is, of course, more research laboratories all along the line. The increase would naturally be among industrial organizations and the expense borne largely by manufacturing concerns, since it is they who reap the chief direct financial benefit.

Another great need is cooperation among the various branches of research: university, national and industrial. There should be a free interchange of men between such laboratories, and each should be thoroughly familiar with the needs and problems of the other. One great benefit from this war, if it lasts sufficiently long, will be to force cooperation between different branches of research.

III. *The Application of Organized Knowledge.*—The present national crisis brings home to us the crying needs of the nation in availing itself of the knowledge and ability at its command. Fifty thousand specialists in applying scientific knowledge to practical problems as well as scores of research laboratories have offered their services to the nation. But problems requiring investigation are slow in being developed. Once they are formulated and given to the engineers of the country, few will remain unsolved very long.

It is for the engineer to apply the results of research to practical problems and to carry practical problems demanding general research back to the research laboratories. To the engineer, every special problem requires a special application of fundamental principles. Is it too much to hope that the day is rapidly approaching when

all great problems, particularly those of our national and state governments, will be automatically placed in the hands of trained specialists? Not self-seeking politicians, nor yet men with mere theories, but engineers with a real command of fundamental principles, men with an unbroken record of big achievements and no failures, men ever ready to stake their all on their ability to handle problems in their specialty.

Professor Joseph Le Conte, in an address years ago, remarked that each of the great professions first attained high standing when it was taught as such in universities. When so taught, the professional men turned out are no longer quacks, but each has a real command of the fundamental principles in his chosen field of action. The basic relation is that any profession has standing in so far as its fundamental principles have been developed and applied. To retain standing, a profession must be continually increasing its stock of knowledge of fundamental principles through research. The engineer of standing in his profession must not be content with a mere working knowledge of rules of thumb, but must have a real command of basic principles in his chosen field and in related fields. The illuminating engineer, for example, should know not only lighting, but should possess a working knowledge of the laws of vision and of geometrical and physical optics. So the great physician or construction engineer has a command of his own field and an intimate acquaintance with related fields.

So also with research as a profession, the leaders have not only a taste for research and logical minds to clearly analyze and attack problems with thorough scientific knowledge, but have a knowledge of the principles of research; getting the most out of their own minds, avoiding side issues, cooperating with their colleagues and putting their most valuable results in permanent, readily available form. Research is one of the youngest of the professions and one with a promising future, but let no one enter it without thorough knowledge or a full understanding of its aims and methods. With sufficient attention given to research and to its application, this nation with its great national resources should at once attain and retain a permanent lead among the nations of the earth.

P. G. Nutting

THE PROOF OF MICROBIAL AGENCY IN THE CHEMICAL TRANSFORMATIONS OF SOIL

Every now and then in the development of a science it is well to stop and consider how many of the current statements are based on established fact and how many have arisen from assumptions repeated so often that they have come to be generally believed. Certain common statements in regard to the bacteriology of soil may well bear such scrutiny. Has it, for instance, been definitely proved that any particular microorganisms cause any of the well-known biological activities in soil? This question is quite pertinent at present because of statements frequently found in the literature that certain bacteria or groups of bacteria are responsible for certain chemical transformations in soil, although complete proof of the causal relation has never been obtained.

The cause of these loose statements is easy to understand when it is considered that it is practically impossible to obtain direct evidence as to what actually goes on within the soil. Laboratory experiments show what the microorganisms do under laboratory conditions, but not what they do in the soil. Even though the activity of an organism be tested in soil itself, its true activity in the field may still remain unknown, because such laboratory tests have to be carried out in pure culture, and pure cultures do not occur in the field. The activities of bacteria in soil are associ-

ative actions; and an organism capable of vigorous activity in pure culture may be almost inactive in the presence of its natural rivals. Laboratory tests, therefore, give but indirect evidence at their best. Indirect evidence has its value; but it is futile to draw conclusions from it unless results obtained by one method are confirmed by those obtained in some other way.

Similar difficulties in regard to pathogenic bacteria caused the literature of the early nineteenth century to abound in misstatements as to the relation of certain bacteria to certain diseases. Gradually, however, it came to be recognized that neither the constant presence of a given microorganism in a certain disease, nor its ability to produce a similar disease in lower animals proves it to be the causal agent of a human disease. These ideas were put in concise form by Koch when he restated and emphasized the requirements originally suggested by Henle as necessary steps in proving a given organism to be the cause of a given disease. These postulates, as stated by Koch, are as follows: (1) The organism must be shown to be present in abundance in the tissues, blood, or discharges of animals suffering from the disease; (2) it must be isolated and studied in pure culture; (3) it must be shown capable of producing the same disease in healthy animals; (4) it must subsequently be found again in abundance in the experimentally inoculated animals.

Really the case of bacterial activities in soil is analogous. The constant presence of a certain organism in manured soil, for instance, does not prove that it decomposes the manure any more than the constant presence of an organism in a given disease proves its causal relation. Neither does the fact that an organism ammonifies laboratory media prove that it ammonifies organic matter in soil, any more than the fact that an organism produces a certain disease in a lower animal proves that it produces a similar disease in man. Although this fact may be recognized in a general way by soil bacteriologists, a little thought will show that no rules as strict as Koch's postulates have ever been followed in establishing the agency of bacteria in any soil activity—with the exception of the bacteria of legume nodules. Even in regard to the nitrifiers—certain as we may be of their agency in converting ammonium salts into nitrates—we do not have the complete proof. This thought is somewhat disconcerting and shows the need of drawing up strict rules to apply to the activities of soil microorganisms. Koch's postulates can not be applied directly to soil microorganisms, because the latter operate under quite different conditions from pathogenic bacteria; but it is possible to modify his rules to fit soil conditions.

The first postulate is that the organism must be shown to be present in abundance in animals suffering from the disease in question. It is equally necessary to show that an organism is present in abundance in soil in which a certain biological activity is going on—in fact that it is more abundant in such soil than in similar soil in which the activity is not taking place—before asserting that the organism in question is the causal agent. It is also necessary to show that the organism is present in such soil in *active* form. This is necessary because at least three groups of soil microorganisms have inactive as well as active forms: namely, protozoa, molds and spore-bearing bacteria. If the organism in question belongs to one of these three groups, the mere demonstration of its presence is not enough, but it must be shown to be present in active form. In other words, Koch's first postulate must be expanded as follows when applied to soil conditions: The organism in question must be shown to be present in active form when the chemical transformation under investigation is taking place; and must also be shown to be present in larger numbers in such soil than in similar soil in which the chemical change is not taking place. These two steps have seldom been carried out in investigating the cause of any biological activity in soil, but they are nevertheless as important as Koch's first postulate in regard to pathogenic bacteria. They are perhaps a little more stringent than the first postulate of Koch's; but special stringency is necessary here in view

of the difficulty in applying Koch's last two postulates to soil conditions.

The second postulate of Koch's is that the organism be isolated and cultivated in pure culture. This can be applied without modification to soil conditions, and indeed is generally carried out by soil investigators.

The third postulate is that the organism be shown capable of producing the same disease in healthy animals. The corresponding requirement in regard to soil bacteria is extremely difficult to meet. It is possible to inoculate the organism in question into sterile soil and study its activity under such conditions—a test which is quite commonly made. Such a test, however, does not furnish conclusive proof. Sterilized soil is always different from natural soil; but worse still, activities in pure culture may be very different from activities in mixed culture. To obtain complete proof, the organism in question should be inoculated into unsterilized soil, and then if the activity under investigation occurs the organism should be shown to be present in large numbers. Such a procedure, however, is generally impossible, because of the difficulty of getting an organism to grow vigorously in soil already stocked with a bacterial flora of its own; and the interpretation of results is difficult, because—in distinct contrast to the specific agency of microorganisms in disease—the same chemical transformation in soil may be caused by distinctly different organisms. For this reason the best that can ordinarily be done is to inoculate the organism in question into sterilized soil. To do so furnishes better proof than to inoculate it into any laboratory medium, but the unsatisfactory nature of the test must be fully recognized. Perhaps it is not overstating the case to say that much of the past confusion in regard to the activities of soil bacteria has arisen from the fact that they have been studied in pure culture while pure cultures never occur naturally in soil. The inoculation of sterilized soil is ordinarily the only practical course, however, and has its value as a means of confirming the tests carried out in connection with the requirements already mentioned.

Koch's last postulate is that the organism be found in the tissues, blood or discharges of the experimentally inoculated animals. The corresponding requirement in regard to soil activities is superfluous, provided sterile soil is used for inoculation and contamination is prevented during the experiment. If unsterilized soil is used, the presence of the organism in question should be demonstrated; but the impractibility of using unsterilized soil makes this last requirement of little value as applied to soil conditions.

Summing up, it may be said that to show conclusively the agency of any microorganism in any chemical transformation occurring in soil, the following steps are necessary: (1) The organism must be shown to be present in active form when the chemical transformation under investigation is taking place; (2) it must be shown to occur in larger numbers under such conditions than in the same soil in which the chemical change is not occurring; (3) it must be isolated from the soil and studied in pure culture; (4) the same chemical change must be produced by the organism in experimentally inoculated soil, making the test, if possible, in unsterilized soil. The fourth reqiurement, however, can ordinarily be carried out only by inoculating sterilized soil, a procedure which does not give rigid proof, but which is fairly conclusive if carried out in connection with the other three requirements.

Sometimes these facts can be brought out wholly by cultural methods, such as used in the past. It must be remembered, however, that cultural methods, at their best, are open to serious error, as organisms that are naturally inactive may become active under cultural conditions, while under similar conditions naturally active organisms may lose their activity. This fact will make it necessary to check up cultural methods with methods of other sorts. Possibly the use of the microscope[1] will help solve some of the problems,

[1] See Conn, H. J., 1917, "The Direct Microscopic Examination of Bacteria in Soil." (Paper presented at New Haven meeting of the Society of American Bacteriologists.) Abstract in "Abstracts of Bact.," Vol. 1, p. 40.

or perhaps methods of an entirely new sort will be needed. At all events, more attention must be given to the steps involved in proving the causal relation of definite microorganisms to definite biological activities in the soil in order to avoid making loose statements in regard to the functions of these organisms, such as have often been made in the past.

H. JOEL CONN
N. Y. AGRICULTURAL EXPERIMENT STATION,
GENEVA, N. Y.,
July 25, 1917

THE FIRST PUEBLO RUIN IN COLORADO MENTIONED IN SPANISH DOCUMENTS

THERE is in the Congressional Library, among the documents collected by Peter Force, a manuscript diary of early exploration in New Mexico, Colorado, and Utah, dated 1776, written by two Catholic priests, Father Silvester Velez Escalante and Father Francisco Atanacio Dominguez. This diary is valuable to students of archeology, as it contains the first reference to a prehistoric ruin in the confines of the present state of Colorado, although the mention is too brief for positive identification of the ruin.[2] While the context indicates its approximate site, there are at this place at least two large ruins, either of which might be that referred to. I have no doubt which one of these two ruins was indicated by these early explorers, but my interest in this ruin is both archeological and historical. Our knowledge of the structure of these ruins is at the present day almost as imperfect as it was a century and a half ago.

The route followed by the writers of the diary was possibly an Indian pathway, and is now called the old Spanish Trail. After entering Colorado it ran from near the present site of Mancos to the Dolores. On the fourteenth day from Santa Fe, we find the following entry: "En la vanda austral del Vio [Rio] sobre un alto, huvo antiquam (te) una Poblacion pequeña, de la misma forma q^{e} las de los Indios el Nuevo Mexico, segun manifieran las Ruinas q^{e} de invento registramos."

By tracing the trip day by day, up to that time, it appears that the ruin referred to by these early fathers was situated somewhere near the bend of the Dolores River, or not far from the present town of Dolores, Colorado. The above quotation indicates that the ruin was a small settlement, and situated on a hill, on the south side of the river or trail, but it did not differ greatly from the ruined settlements of the Indians of New Mexico with which the writers were familiar, and had already described.

A century later, 1876, we find a published reference to a ruin near the bend of the Dolores, which suggests the above mentioned. An exploring expedition of the engineer department of the United States Army from Santa Fé, New Mexico, to the junction of the Grand and Green Rivers of the Great Colorado of the west, under command of Capt. J. M. Macomb, U. S. A., in 1859, followed the old Spanish Trail. Professor J. S. Newberry, of the expedition, in a geological report described a ruin not many miles from the bend of the Dolores: "Surouaro is the name of a ruined town which must have contained a population of several thousands [*sic*]. The same is said to be of Indian (Utah) origin, and to signify desolation, and certainly no better could have been selected. . . . The houses are, many of them, large, and all built of stone, hammer-dressed on the exposed faces. Fragments of pottery are exceedingly common, though, like the buildings, showing great age. The remains of metates (corn mills) are abundant about the ruins. The ruins of several large reservoirs[3] built of masonry may be seen at Surouaro, and there are traces of acequias which led to them through which water was brought perhaps from a great distance."

[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] Diario y Dereotero de las neuvas descubrimientos de tierras á los r'bos N.N.OE.OE. del Nuevo Mexico por los R.R.P.P.Fr. Silvester Valez Escalante, Fr. Francisco Atanacio Dominguez, 1776. (*Vide* Sen. Ex. Doc. 33d Congress, No. 78, pt. 3, pp. 119–127.)

[3] Probably kivas, but impossible to identify without excavations. J. W. F.

On several maps, as that accompanying a report of another survey across the continent, by William J. Palmer, published in 1867 and 1868, sites of ruins are indicated in southwestern Colorado. Printed references to Surouaro are made by Jackson, Holmes, Prudden, and other writers, but aside from the statement of the last mentioned, that it is a cluster of mounds indicating pueblos of the unit type, we know little regarding their size and architectural peculiarities. The arrangement of mounds in a cluster, like many others in the cedar clearings, suggests the Mummy Lake group on the Mesa Verde, and it is probable that each member of the group if excavated will be found to resemble Far View House.

My attention was called to a ruin near Dolores by Mr. R. W. Williamson, of that city, and not being able to visit the site I urged him and others to collect more details, from which my belief was confirmed that the ruin mentioned by the Spanish fathers is the same as Newberry's Surouaro.

As one fruit of my inquiries for corroboratory evidences bearing on the identification of the oldest mentioned ruin, I obtained unexpected information from Mr. J. W. Emerson, a ranger on the Montezuma Forest Reserve, who is well acquainted with the region near Dolores. In a letter received a short time ago from Mr. Gordon Parker, supervisor of the reserve, who has always shown great interest in my work at the Mesa Verde, there was enclosed a copy of a report made by Mr. Emerson to the Forest Service, on a remarkable ruin near Dolores which, although not corroborating the above identification, greatly intensified the desire of several years to visit the area in which lies the supposed first ruin in Colorado mentioned in writings by white men. Mr. Emerson's report is accompanied by a rude ground plan, indicating a ruin as unusual in form as the mysterious Sun Temple of the Mesa Verde Park, which it somewhat resembles.

It does not answer the description of Surouaro by Newberry, and its exceptional character would not have impressed the Spanish fathers, if they noticed it at all. In fact, judging from the "ground plan" furnished by Mr. Emerson, its form is remarkable even in a region where many different forms exist.

I will not occupy the reader's time with the details of the building revealed in this report, as they would be more appropriate in a formal article and can be greatly augmented by excavations, but will point out that its form is roughly semicircular, the plan showing concentric walls bounding rooms separated by partitions, the outer straight wall on the south side being like the south wall of Sun Temple. The building measures 100 by 80 feet, exhibiting masonry characteristic of the purest pueblo type. A complete excavation promises to reveal data on the connection between the prehistoric towers of the southwest, circular ruins, and the problematical Sun Temple.

It is evident that the southwestern corner of Colorado, from which locality not a single ruin had been recorded a century and a half ago, contains some of the largest, best constructed, and most mysterious pueblo ruins and cliff dwellings in the United States, and offers unusual data bearing on the history of aboriginal American culture.

J. Walter Fewkes
Bureau of American Ethnology,
Smithsonian Institution

SCIENTIFIC EVENTS

PRODUCTION OF NITRATES BY THE GOVERNMENT

Announcement is made by the War Department of its preparations for the production of nitrates in accordance with a report filed by the Nitrate Supply Committee. This report is given in part below. It is further stated that for the present the location of the proposed nitrate plant is withheld, but information concerning its location will be given as soon as a definite decision is reached. The work of supplying the machinery and materials needed for the plant has begun.

The Nitrate Supply Committee, appointed by the Secretary of War, was under authority of a provision in the national defense act for an investigation "to determine the best,

cheapest and most available means for the production of nitrates and other products for munitions of war and useful in the manufacture of fertilizers and other products."

The general recommendations and report of the Nitrate Supply Committee are announced as follows:

After a deliberate and careful consideration of all the matter and information at the disposal of the committee, it submits the following as its action:

1. The committee, appreciating the offer of the General Chemical Company, recommends that the government enter into negotiations to acquire the rights to use the synthetic ammonia process of that company.

2. That contingent upon satisfactory arrangements with the General Chemical Company, out of the $20,000,000 nitrate supply appropriation such sum as may be needed, now estimated at $3,000,000, be placed at the disposal of the War Department to be used in building a synthetic ammonia plant, employing the said process of the General Chemical Company, and of a capacity of 60,000 pounds of ammonia per twenty-four-hour day, said plant to be located in a region where land, water, coal and sulphuric acid are cheaply available, where good transportation facilities exist, and where the proposed new powder plant of the government can be properly located. In the opinion of this committee all of these conditions just enumerated are best fulfilled by a location in southwest Virginia or contiguous region.

3. That out of the $20,000,000 nitrate supply appropriation an amount now estimated at $600,000, or as much as may be needed, be placed at the disposal of the War Department to be used in building a plant for the oxidation of ammonia to nitric acid and the concentration of nitric acid, of a capacity equivalent to 24,000 pounds of 100 per cent. nitric acid in a twenty-four-hour day, said plant to be located in the neighborhood of the aforesaid synthetic ammonia plant and the proposed new powder plant of the government.

4. That the War Department proceed at the earliest practical date with the construction of the oxidation plant and contingent upon a satisfactory arrangement with the General Chemical Company, also with the synthetic ammonia plant, and that the government give such priority orders as will secure from contractors prompt delivery of the materials and rapid construction of the structure and machinery needed for those plants.

5. The committee, appreciating the offer of the Nitrogen Products Company granting, in this country, to the government, under certain conditions, the right to use the so-called Bucher process for the production of sodium cyanide and ammonia, recommends that a form of contract, drawn with the advice of the legal authorities of the government, such as to give that company no guaranty or exclusive rights in the process, or in its future development, beyond those which the company's own patents give to it, be entered into with the Nitrogen Products Company, and that experimentation looking toward the industrial development of the Bucher process for the production of ammonia be at once proceeded with. And, further, that contingent upon a satisfactory arrangement with the Nitrogen Products Company, a sum not to exceed $200,000 be allotted for this purpose out of the $20,000,000 nitrate supply appropriation.

6. That out of the $20,000,000 nitrate supply appropriation $100,000 be made available for the active prosecution of investigations of processes for the industrial production of nitrogen compounds useful in the manufacture of explosives or of fertilizers, and that these investigations be planned and supervised by the War Department.

7. That in order to increase the production of ammonia and toluol the government promote the installation of by-product coke ovens by directing that priority be given in the production, delivery, and transportation of the materials and parts needed in their construction.

8. That the decision as to more extensive installation of nitrogen fixation processes and water power development in connection with them be postponed until the plants above rec-

ommended are in operation or until further need arises.

9. While the preceding recommendations include all the measures that can now judiciously be taken for the fixation of nitrogen and the oxidation of ammonia, it is the opinion of the committee that the immediate accumulation and the permanent maintenance of an ample reserve, not less than 500,000 tons of Chile saltpeter, is the measure most urgently necessary.

The Nitrate Supply Committee comprised the following Army and Navy officers, scientific men and engineers:

Brig. Gen. William Crozier, Chief of Ordnance, War Department; Rear Admiral Ralph Earle, Chief of the Bureau of Ordnance, Navy Department; Brig. Gen. William M. Black, Chief of Engineers U. S. A.; F. W. Brown, Bureau of Soils, Department of Agriculture; Leo H. Baekeland, Yonkers, N. Y.; Gano Dunn, New York City; Charles H. Herty, New York City; William F. Hillebrand, Bureau of Standards, Department of Commerce; Arthur A. Noyes, Institute of Technology, Boston, Mass.; Charles L. Parsons, Bureau of Mines, Interior Department; and Willis R. Whitney, Schenectady, N. Y.

THE ARMY AVIATION SCHOOL AT THE UNIVERSITY OF CALIFORNIA

In the United States Army School of Military Aeronautics at the University of California the following appointments have been made:

Major Arnold N. Krogstad, J.M.A., Signal Corps, commandant, quartermaster, ordnance officer, summary court, president of examining board.

Dr. B. M. Woods, president of academic board.

First Lieutenant Bruno F. Sandow, Medical Reserve Corps, post surgeon, member of examining board.

First Lieutenant Gerald F. Stoodly, Dental Reserve Corps, dental surgeon.

M. S. E. Herman H. Walker, Signal Corps, retired, clerk, commandant's office.

M. S. E. Milton N. Williams, Signal Corps, retired, acting quartermaster sergeant.

Private Joseph L. Walker, A.S., Signal Corps, assistant instructor in rigging.

Professor B. F. Raber, associate professor of mechanical engineering and professor of aeronautical engines.

D. J. Conant, professor of aeronautical engines.

Donald B. McFarlane, instructor in gas-engine practise.

F. H. Bachman, instructor in internal-combustion engines.

Collier Raber, mechanic and tool-room keeper.

J. A. Polhemus, instructor in theoretical mechanics.

H. M. Jeffers, instructor in astronomy and meteorology.

W. D. Waterman, instructor in rigging, structure and care of aeroplane.

R. J. Heffner, instructor in maps and reconnaissance.

E. N. D'Oyly, instructor in artillery observation and use of miniature artillery range.

Dr. L. T. Jones, instructor in physics and professor of machine guns.

F. S. Stockton, G. R. McDonald and Herbert G. Russell, instructors in machine guns.

R. B. McPherson, instructor in wireless and signaling.

Harold Fielder, instructor in wireless.

E. S. Pillsbury and E. F. Steen, instructors in military tactics and lecturers.

Clifton R. Gordon, J. C. Moses and G. G. Mitchell, instructors in military tactics.

F. W. Cozens, instructor in physical education.

Grandison Gardner, instructor.

APPOINTMENTS IN THE ORDNANCE DEPARTMENT OF THE ARMY

The United States Civil Service Commission announces the following open competitive examinations for positions in the several ordnance establishments of the War Department or in or under the office of the Chief of Ordnance, War Department, Washington, D. C. The salaries named are for entrance.

Mechanical engineer, artillery ammunition, $3,000 to $3,600 a year.

Mechanical engineer, experimental work, $2,500 to $3,000 a year.

Mechanical draftsman, $1,000 to $1,400 a year.

Apprentice draftsman, $480 a year.

Inspector of artillery ammunition, $1,500 to $2,400 a year.

Inspector of field artillery ammunition steel, $1,500 to $2,400 a year.

Assistant inspector of field artillery ammunition steel, $3.50 to $5 a day.

Inspector of ammunition packing boxes $3.52 a day to $1,800 year.
Inspector and assistant inspector of powder and explosives, $1,400 to $2,400 a year.
Inspector of ordnance equipment, $1,500 to $2,400 a year.
Assistant inspector of cloth equipment, $80 to $125 a month.
Assistant inspector of leather, $100 to $125 a month.
Assistant inspector of small hardware, $80 to $125 a month.
Assistant inspector of textiles, $80 to $125 a month.
Assistant inspector of leather equipment, $100 to $125 a month.
Clerk qualified in business administration, $1,200 to $1,500 a year.
Index and catalogue clerk, $1,000 to $1,200 a year.

The examination for index and catalogue clerk is open to both men and women; the other examinations are open only to men.

The president of the commission writes that the government urgently needs men for the work above indicated, and qualified persons are urged, as a patriotic duty, to apply for examination. Until further notice applications for the positions named will be received at any time by the United States Civil Service Commission, Washington, D. C. Papers will be rated promptly. Applicants will not be required to appear at any place for examination, but will be rated principally upon the elements of education, training and experience, as shown by their applications and by corroborative evidence.

Full information concerning examinations, application blanks, etc., may be obtained by calling in person upon the secretary of the local board of civil service examiners at the post office in any city in which city delivery of mail has been established, or by communicating with the United States Civil Service Commission, Washington, D. C.

SCIENTIFIC NOTES AND NEWS

SIR CLIFFORD ALLBUTT has been continued in the office of president of the British Medical Association for the coming year. It is hoped that a meeting will be held at Cambridge next year.

PROFESSORS GOLGI, NOVARO AND ROSTER, having reached the age of seventy-five years, automatically retired from their chairs in Italian universities. Professors Golgi and Novaro are both senators of the realm. The former is professor of general pathology at Pavia, and Novaro of surgery at Genoa. Roster is professor of hygiene at Florence.

THE Secretary of War announces the appointment of the following to investigate the matter of defective ammunition sent to the American expeditionary force in France: Dr. H. P. Talbot, professor of chemistry at the Massachusetts Institute of Technology; Dr. C. L. Parsons, chief chemist of the Bureau of Mines; an army officer to be named by Major General Hugh L. Scott, Chief of Staff.

THE United States Food Administration announces that Professor H. A. Morgan, of Knoxville, Tenn., has been appointed federal food administrator for Tennessee.

DR. ARTHUR M. SHIPLEY, of Baltimore, professor of surgery at the University of Maryland, who had received his commission as chief of the surgical staff of the University of Maryland Base Hospital Unit, has been detached from the unit by order of the War Department, and ordered to report immediately to Camp Meade as chief surgeon and surgical instructor at the camp.

E. N. WENTWORTH, professor of animal breeding at the Kansas State Agricultural College, has received a commission of captain in field artillery. For the present he will be stationed at Fort Riley.

ROBERT A. PATTERSON, Ph.D., instructor in physics in Yale College, has been commissioned captain in the field artillery section of the Reserve Officers' Corps, and assigned to the camp at Ayer, Mass.

DR. LEON I. SHAW, of the department of chemistry of Northwestern University, has been advanced to the position of assistant professor of chemistry on leave of absence for one year for service with the government. He

has received the appointment of first lieutenant in the Ordnance Officers' Reserve Corps.

D. W. Blakeslee, electrical engineer and assistant superintendent, Penn Electrical and Manufacturing Co., Irwin, Pa., has been ordered to report at Washington for active duty as first lieutenant in the Engineer Section, Officers' Reserve Corps, United States Army.

Dr. Edward G. Birge, director of the State Bacteriological Laboratory, Jacksonville, Florida, has been given an indefinite leave of absence by the Florida State Board of Health. Dr. Birge has received a commission as captain with the Medical Reserve Corps of the United States army.

The *Journal* of the American Medical Association states that Dr. Charles Wardell Stiles, U. S. Public Health Service, has discovered forty-seven cases of hookworm in seventy-five recruits mobilized for war service, and these findings have caused the United States Public Health Service to recommend the prompt examination for hookworm of all units of the national guard and national army, especially those from the south.

Surgeon French Simpson, U. S. Public Health Service, has been ordered to Columbia, S. C., to take charge of the campaign against malaria.

Dr. B. Frank Knause, of Brooklyn, N. Y., has been appointed deputy commissioner and sanitary superintendent at a salary of $6,000 a year. The appointment is also announced of Dr. Herman Tapley Peck, also of Brooklyn, as assistant sanitary superintendent at $5,500 a year.

E. W. Jahnke has been appointed superintendent of the state grain and seed laboratory at Bozeman in connection with the State College of Montana, to succeed B. Whitlock, who resigned to accept a position with the federal department of agriculture in the administration of the grain standardization act. Mr. Whitlock will have his headquarters at Salt Lake, and will superintend the administration of the law over a large part of the northwest. Mr. Jahnke who becomes superintendent at Bozeman has been an assistant to Mr. Whitlock for the past two years.

Mr. Arthur T. Bolton has been appointed curator of Sir John Soane's Museum, Lincoln's Inn Fields, in succession to the late Mr. W. L. Spiers.

A Reuter despatch to the daily papers states that Professor Kenzo Futaki claims to have discovered, after three years' original research work in the Japanese Imperial Government Laboratory, the specific cause of typhus fever. He calls this new germ the *Spirochæte exanthematotyphis*.

Dr. Colin G. Fink, for the past ten years in the Research Laboratories of the General Electric Company, has been appointed head of the new Chile Exploration Company laboratories, located at 202d Street and 10th Ave., New York City. The work in the new laboratories will be largely research along metallurgical and electrochemical lines.

Dr. L. F. Nickell, formerly assistant professor of chemistry at Washington University, has resigned to become chemist in the research department of the Monsanto Chemical Works in St. Louis.

Dr. Charles K. Francis, for the past seven years chemist and professor of petroleum technology in the Oklahoma Agricultural and Mechanical College, has resigned to become chief chemist for the Cosden Oil Company, Tulsa, Okla.

Professor Francis Ramaley, who has been making vegetation studies in California since February, has returned to his work at the University of Colorado.

Professor C. E. Clewell, of the University of Pennsylvania, delivered on September 10 his fourth annual lecture on the fundamental principles of natural and artificial factory lighting before the junior students in electrical and mechanical engineering in the summer term of mechanical technology at the Sheffield Scientific School of Yale University.

The death is announced of Major-General T. Rosati, surgeon-general of the Italian navy, at the age of fifty-seven years. He was

formerly professor of ear and throat diseases at the University of Naples.

DR. ELIOT R. CLARK, professor of anatomy in the University of Missouri, recently delivered an address on "Some aspects of the problem of endothelium," and Dr. Frederick G. Novy, professor of bacteriology in the University of Michigan, an address on "Anaphylaxis" before the faculty and students of the graduate summer quarter in medicine of the University of Illinois.

THE Cavendish lecture of the West London Medico-Chirurgical Society was delivered by Captain Andrew Macphail, Canadian Army Medical Corps, who is professor of the history of medicine at McGill University, Montreal, who took as his subject "A Day's Work."

A NEW pedestal for the bust of John Muir, naturalist and explorer, is now being made at the University of Wisconsin to be placed in the Building for Biology, where the bust of Muir now stands. The pedestal will bear this inscription:

JOHN MUIR, 1838–1913
AUTHOR, EXPLORER, NATURALIST
A PRIEST AT NATURE'S SHRINE.

CHARLES HOWARD PARMLY, professor of physics of the College of the City of New York, died at Ashland, N. H., from cerebral hemorrhage on September 8, aged forty-nine years.

DR. G. STANCULEANU, professor of ophthalmology at the University of Bucharest until the German invasion, who has been lecturing in this country in the interest of the Roumanian government, died recently of pneumonia at a sanatorium at Stamford, Conn.

THE death is announced of Dr. Charles Mongour, professor of internal pathology and medical jurisprudence at the Bordeaux Medical School.

IT is stated in *Nature* that the mycological collection of the late Dr. J. W. Ellis has been acquired by purchase by the herbarium at Kew. It comprises nearly 1,600 dried specimens, is especially rich in micro-fungi, and includes a series of mounted specimens of those of economic importance. There are also 330 microscopic slides.

UNIVERSITY AND EDUCATIONAL NEWS

As a war measure a limited number of women may be admitted this year to the courses of the Harvard Medical School. They will not receive or be eligible to receive the university degree. Formal action has not been taken by the corporation, but tentative arrangements are being made and will probably become effective by the time college opens for the new session.

THE department of forestry of the University of Idaho has recently been segregated from the College of Arts and Science as an independent school. Professor F. G. Miller, formerly head of the department of forestry at Washington State College, has been elected dean of the school, and professor of forestry.

DR. HENRY KRAEMER, for twenty years professor of botany and pharmacognosy at the Philadelphia College of Pharmacy, will succeed the late Dr. Julius O. Schlotterbeck as professor of pharmacognosy of the college of pharmacy of the University of Michigan.

ALMON H. FULLER, dean of the school of engineering at the University of Washington, Seattle, has accepted the appointment to the head of the department of civil engineering at Lafayette College to succeed Professor J. Madison Porter. Donald B. Prentice, of the Sheffield Scientific School, Yale University, has been appointed assistant professor of mechanical engineering. He will take charge of the work in boilers and heat engineering hitherto cared for by Professor Fitch.

DR. H. B. SHAW, former dean of the School of Engineering of the University of Missouri, has been appointed supervisor of the Doherty cadet school. Dr. Shaw's duties will include the selection of men from the universities of the country to become Doherty cadets, to supervise the courses and to recommend cadets for regular posts in the organization. He will make his headquarters, it is expected, in Toledo, Ohio.

Dr. Truman Lee Kelley, of the University of Texas, has been elected assistant professor of education at Teachers College, Columbia University. Dr. Kelley is to devote a large part of his time to research on psychological measurements in secondary education.

Northwestern Uiversity Medical School announces the following faculty appointments for 1917–1918: Drs. Frederick G. Harris, professor of dermatology and syphilology, succeeding Professor Joseph Zeisler, who becomes professor emeritus of dermatology; Frank C. Becht, professor of pharmacology, succeeding Professor Hugh McGuigan; John Ridlon, honorary professor of orthopedic surgery; John L. Porter, professor of orthopedic surgery; Herbert A. Potts, professor of oral surgery; Frank E. Simpson, adjunct clinical professor of dermatology; Charles P. Caldwell, adjunct clinical professor of medicine; Edward L. Moorhead, adjunct clinical professor of surgery.

DISCUSSION AND CORRESPONDENCE

TESTS OF RADIATOR HUMIDIFIERS

By request of physicians I have tested four types of radiator humidifiers on the market in Minneapolis. The experiments were performed at my house, which is heated by hot water. For the first three types mentioned the tests were made at the same time on the same radiator. The results are therefore strictly comparable. The results for the "Flobun" were obtained at a later date. All results have been calculated to indicate evaporation, per twenty-four hours, for each horizontal foot of radiator occupied by the apparatus.

RESULTS

"Speco," av. of 3 tests, zero weather, January, 1916	294 g.
"Savo," av. of 3 tests, zero weather, January, 1916	230 g.
"Buddington," av. 3 tests, zero weather, January, 1916	1,116 g.
"Flobun," av. of 2 tests, zero weather, December, 1916	1,248 g.

These results for the "Buddington" and "Flobun" were obtained using wicks which were new or nearly new. But the efficiency of both instruments rapidly falls if tap water is used, owing to clogging of the wicks. In two days the loss of efficiency in one series of experiments with the "Flobun" was 25 per cent.

Inasmuch as 10 to 30 gallons of water (Bryce, of Ottawa, says 75 gallons) must be evaporated daily in an ordinary-sized house to maintain reasonable humidity under the conditions of our northern winters, it will be seen that these radiator devices are practically worthless. Using the sling psychrometer I was never able to detect an increase of humidity from the use of any of them. Indeed, the best of them is no more efficient as an air moistener than one human being. The average evaporation from lungs and skin of a large laboratory class in subzero weather, and about 70° inside temperature, was nearly two ounces per hour per person, or about 1,200 grams a day.

E. P. Lyon
University of Minnesota

A NEW METEORITE

About 6:20 p.m., July 4, 1917, there fell within the corporate limits of Colby, Wis., in the western part of the city, which is in the county of Clark, an achondritic aerolite, the fall of which was witnessed by a considerable number of people.

Unfortunately, knowledge of this fall did not come to me until two weeks later and a visit to the locality was made on July 24, at which time the stones had become considerably broken up and dispersed.

Two pieces fell, the smaller about one half mile NNE. from the other. The larger stone fell in a pasture, striking a granite rock, at least two inches in thickness, lying upon or near the surface, breaking this rock into many fragments and itself breaking into twenty-seven or more pieces. The larger mass, weighing 22¾ pounds, penetrated the stiff Colby clay to a depth of five feet. Some of the smaller pieces are said to have distributed themselves laterally in the soil to the extent of about four feet.

The smaller stone fell in a cultivated field without breaking and is said to have penetrated the soil about two feet. This stone is variously described as about 10 x 14 x 3 or 4 inches, 17 or 18 inches by 9 x 9 inches and 21 x 11 x 11 inches at larger end, sloping in two directions to a wedge shape with rounded corners. This piece was said to be entirely covered with crust and to have weighed from 75 to 85 pounds.

The man who extracted it from the earth informs me that it was so cold that frost immediately formed on its surface when exposed to the air.

The Public Museum of the City of Milwaukee has obtained the bulk of the larger mass which will be analyzed and duly published. It probably will be distributed in exchange with several museums.

The stone is of a light gray groundmass, apparently largely feldspathic, containing very few chondrules and thickly shot with pyrrhotite varying from specks a fraction of a millimeter to more or less globular masses 5 mm. in diameter. It exhibits sundry black veins and armored surfaces. Its crust shows considerable variation on different pieces, some of which are deeply pitted and others comparatively smooth.

This is, I believe, the sixth meteorite known from the state of Wisconsin and will be known as the Colby meteorite.

HENRY L. WARD
PUBLIC MUSEUM OF THE
CITY OF MILWAUKEE,
July 31, 1917

FILING PAMPHLETS

THE communications relative to filing reprints, bulletins and other pamphlets have been read with considerable interest by the writer and further suggestions are offered.

Having been in experiment station work for a number of years and being on the mailing lists of a large number of stations, the literature, particularly bulletins and circulars, has been accumulating rapidly. Of these, there may be many which may be of no immediate interest and attempts have been made repeatedly to find some system for filing and indexing them, which will give a maximum of usefulness with a minimum of work in arranging and filing. Many of the various systems have been tried with the result that owing to the time required for arranging, one becomes confronted with an almost hopeless stack of publications if the work be neglected even for a short time.

Numbering in the order of acquisition was early abandoned, on account of the time necessary for preparing index cards and the cross refernces which sooner or later become inevitable, and the resulting jumbled mass of publications on the shelves. Filing according to origin, as by experiment station in the case of such publications, was tried, but this, too, required a card index and, as in the former system, the necessary picking over of the entire shelves when a number of publications on one subject were desired. Filing by author led to the same results. It was finally concluded that in order to obtain a higher degree of efficiency it would be necessary to combine indexing with filing, thus doing away with a large number of indexing cards, and at the same time some of the deficiencies of the other systems of filing. This conclusion led to a search for a fairly complete scheme of classification. The Dewey system was consulted and was found wanting, particularly because the division agriculture was not classified finely enough. The solution of the problem was found in the scheme of classification of the Library of Congress. This may be procured from the Superintendent of Documents at a small price and answers the purpose very well.

In using this scheme, the publications are numbered according to the class number of the subject and placed in the proper filing boxes for each particular subject or subjects. Where a pamphlet contains information on more than one subject it is only necessary to prepare a cross reference card of fairly large size and file it in its proper place among the publications. To prevent "burying" of a publication, a register is used in which the publications are listed according to their origin

with their class numbers. With this arrangement it is possible to locate immediately any publication, even if only its origin is known. The chief advantage of the scheme lies in the fact that all material with cross references on any given subject are immediately available.

For agricultural workers in special lines the classification may not be complete enough but this may be easily remedied by preparing an outline for more minute classification. For the purposes of the writer the heading insecticides and fungicides was further subdivided and this has been very satisfactory so far. As the worker in insecticides and fungicides is often called upon for chemical information in other closely related lines such as parasiticides, germicides, weed killers, poisons for vertebrate pests and the like, it has often been debated whether the classification should belong under economic entomology, where it now is, or agricultural chemistry, or whether there should not be a special heading under agriculture for the entire subject or group of subjects. In such a case, the entire branch might be included under the heading "economic toxicology." This name the writer believes to be original and it appears to fill the need for a name for such a diversified and yet closely related group of subjects.

As to the actual storage of pamphlets, any of the suggestions found in the various communications are of value, provided the unit holder be not too large to facilitate the location of any particular publication.

M. R. Miller
Insecticide and Fungicide Laboratory,
University of California

QUOTATIONS

FINANCIAL SUPPORT FOR THE NATIONAL RESEARCH COUNCIL

At the request of the President of the United States, the National Research Council has been engaged during the past year in mobilizing the research forces of the nation. It has been an enormous task, to which many of the most brilliant workers of the country have given their undivided time. The work has gradually and logically centered at Washington, and the research forces of the country are now quickly available to any department of the government. Development has proceeded to the point where this organization can be truly considered a going machine, forming a connection between the research workers of the country-at-large and the government, and serving as a valuable coordinating influence. With the preliminary work now accomplished, its full value will be more and more nearly attained with each succeeding day.

For the continuance of the work, however, funds will be necessary. Up to the present its operations have cost the government absolutely nothing: office rent, stationery, postage, clerical assistance, etc., have been provided by private contributions, and the time of members of university staffs has been contributed by the respective institutions. For so important a body such an existence is too precarious. If the government needs war material it pays for it and a willing citizenry furnishes the funds through taxation. Are the brains of our scientific men less valuable in this crisis than coal or cotton? As an American citizen we hope that Congress before adjournment will supply adequate funds for the carrying on of the work of the National Research Council on the most intensive and extensive scale possible. We are unwilling to believe that the government of the United States is so pauperized that it must depend on "the passing of the hat" or that it is willing to continue to draw further upon the seriously impaired incomes of our universities in order that the salaries of the men engaged in this work may be met.—*Journal of Industrial and Engineering Chemistry.*

SCIENTIFIC BOOKS

The Principles of Aerography. By Alexander McAdie. Rand McNally & Co., Chicago. 1917. 318 pp., 8vo, 51 ills., 59 charts and diagrams.

"The Principles of Aerography" deals with the most recent advances in meteorology. As to its title, turning to Murray's Dictionary[1]

[1] "A New English Dictionary," 1888, Vol. 1, p. 146.

we find the following: "Aerography, description of the atmosphere. 1753 Chambers Cycl. Supp., 'Aerography, a description of the air, or atmosphere, its limits, dimensions, properties, etc.' 1818 in Todd." This long-forgotten synonym for "meteorology" Professor McAdie seeks to restore as a title for the study of the atmosphere particularly in relation to human safety and progress. The word "meteorology" is so well-intrenched, however, and so comprehensive, that it is not likely, in our generation at least, to be replaced by "aerography."

The purpose and scope of the book are summarized in the opening sentence of the preface, "... to present this new knowledge [of about the last ten years] in a convenient form even if considerably condensed." There is much direct quotation. Thus we have here a useful supplement to American text-books in meteorology, of which the last comprehensive one was published in 1912. The points emphasized are necessarily not the well-known tenets of the science, but its recent developments. "Stress is laid on modern methods of attack and the practical application of whatever knowledge is already available." The most noteworthy feature is the exclusive use of metric and absolute units.

Unfortunately, coherence and clearness seem to have been sacrificed to brevity in the attempt to make the book a college text; with short chapters, numbered sections, and paragraph headings. The successive chapters are: "A brief history of meteorology; units and symbols; temperature scales; thermodynamics of the atmosphere; stratosphere and troposphere; the circulation of the atmosphere; the major circulations; the minor circulations; forecasting storms; the winds; the water vapor of the atmosphere; condensation; dust and microbes; atmospheric electricity; precipitation; floods and notable storms; frosts; [and] solar influences." The lack of a more systematic arrangement of the material probably will be a serious obstacle in the way of the use of the book as a text-book.

The subjects included are, for the most part, well chosen, though many are too briefly discussed. The consistent use of metric units of measurement and weight, and the absolute scale of centigrade temperature and of atmospheric pressure is highly commendable. The author's tables in these units, and his interpretations of aerodynamics place these complexities within reach of the well-taught student. The student, however, may be confused in having absolute pressure units presented as "kilobars" when they are commonly known as "millibars." "Kilobar" has historic precedence over "millibar," it is true; but "millibar" is the internationally accepted term.

On account of omissions or the tantalizing shortness in the treatment of many interesting subjects, the reader may wish that Professor McAdie's book were twice as long. For example, few students probably can understand the brief explanation of energy used in expansion (p. 43); and some may search in vain for an explanation of the prevailing westerly winds. Seeming contradictions are confusing: thus, a statement of the presence of great polar low pressures is followed by a mention of polar high pressures (pp. 54 and 56). It is hard to reconcile the following statement with all other mentions of the temperatures of the upper air: "10° A. Effective temperature of space. At an elevation of 80 kilometers (50 miles) the temperature ranges from 5° to 10° A." (p. 287). This is contrary to the radiation theory of the temperatures of the stratosphere (pp. 50 and 51); and up to 30 kilometers, at least, there is no observational basis for this assumption. Again, some one might ask why the temperature of the atmosphere is below the effective temperature of space. In some places the discussion hinges on quantities depending on perhaps three variables, of which only one is stated: on p. 43, the weight of a cubic centimeter of dry air is stated without mention of temperature and pressure; on p. 58, deflecting force is evaluated without specification of the latitude. Many of the erroneous or weak places in the book are ascribable to brevity. An error may be noted here (p. 139): "[In the atmosphere] if there should be no gradient [of temperature], we should have the density

the same throughout, and the temperature at the highest level would be the same as below." Density could not be the same, for the air is compressible. Finally, a student may wonder at the apparent accuracy with which downpours of rain are measured in all kinds of places, when he sees, for instance, that in a rainstorm lasting "0.0083" hours it rained at a rate of 480 mm. per hour (p. 216).

The volume will probably be of greatest value as a reference accompaniment to a well-ordered course in meteorology. As a reference book for the advanced student, however, it is lacking in footnotes or bibliography; but it offsets this with its wealth of tables computed only with difficulty, and of illustrations and diagrams drawn from valuable, inaccessible sources.

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Cancer, Its Cause and Treatment. II. Volume. By L. Duncan Bulkley. New York, Paul B. Hoeber. 1917.

The author believes, as he explained in his preceding book and as he further elaborates in the second volume, that cancer is essentially excessive intake of animal proteid which is a constitutional disease, due to a faulty nitrogen metabolism. He maintains that it is an excessive intake of animal proteid which is responsible for the great prevalence of cancer. There are additional factors in the etiology of cancer, but they are of relatively minor importance. In the second volume the author records in greater detail his investigations into urinary and blood changes in cancer and some results of his treatment which consists essentially in a vegetarian diet aided by a certain cathartic. In addition the author accepts the views of Ross, according to which cancer is due to a lack of balance in particular mineral salts of the body, especially in the salts of potassium. Dr. Bulkley finds the conclusions of Ross confirmed in his own practise, in which he noticed that a prescription containing potassium acetate gave eminently satisfactory results in the treatment of cancer.

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THE VANISHING INDIAN

The progress of miscegenation among many of the Indian tribes has progressed to a degree that is surprising even to those who for many years have been studying the Indian. While the total number of "Indians" as recorded by the census increases from decade to decade, the fact is that this increase is due wholly to that of mixed bloods; the full-bloods of pure strain are in most localities rapidly disappearing and in a considerable proportion of the tribes have become actually extinct or are on the point of extinction.

Two remarkable examples of this fact have just been experienced by the writer. For years a growing necessity in American Anthropology has been to determine the physical type of the Shawnee, once a large tribe and one of considerable historic importance. No great difficulty was apprehended in this task, as the tribe is still well represented. The most promising part of the tribe was that of the so-called "absentee" Shawnee, on the Shawnee Agency in eastern Oklahoma. They count 569 individuals, quite a few of whom are generally regarded as "full-bloods."

Due to a grant of $100 from the Committee of One Hundred on Research of the American Association for the Advancement of Science, the writer was able to visit the tribe during the early part of August of this year. To his great disappointment the task of finding some pure-bloods became exceedingly difficult. Quite a few of the Indians were found to be "full-bloods," but on inquiry into the family history it was generally learned that the subject was a mixture of Shawnee with the Oneida, Delaware, Creeks, or some other tribe. In conclusion, there were found but three individuals who so far as they or their friends knew were full-blood Shawnee. Two of these were old women and one an old man, all near or over 70 years of age, and two of the three were sister and brother.

The next tribe visited were the Kickapoo, the main body of which to the number of 211 is settled about McLoud, Oklahoma. They were said by the old Shawnee to be practically

the same people with themselves, having at some time in the past had but one camp-fire, and it was generally believed that they would show some full-bloods of pure strain. This proved to be a vain hope. On close inquiry all sorts of mixtures were discovered, even among the oldest men and women of the tribe, but no pure-bloods. Only one single woman of middle age was believed to be possibly a full Kickapoo, but there was no real certainty. Some visiting Kickapoo from Mexico proved no better than the rest, and no hope was given that any pure strain Kickapoo could be found anywhere else.

Thus two tribes, one of which was of considerable importance, may be regarded as lost to science, so far as pure-bloods are concerned. Only a few years ago according to local information there were still a number of old men and women living in both tribes who represented the pure strain. The genuine Indian is rapidly passing away and the work of the anthropologist who endeavors to record the physical type of the various tribes is becoming increasingly difficult.

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ON A SUDDEN OUTBREAK OF COTTON RUST IN TEXAS

IN June 10, 1917, the attention of the writer was called to an outbreak of cotton rust. The specimens were first collected at Mercedes and Edinberg, Texas. A review of the literature seemingly showed that in the United States, the cotton was supposed to be free from rust. The Experiment Station Literature however refers to cotton rust which is not a true rust, but various leaf spots caused by *Pseudomonas malvacearum* E. S. and *Glomerella gossypii* (South.) Edg.

Symptoms.—The disease is characterized by circular spots which vary from one tenth to one quarter of an inch in diameter. The spots, however, are often much larger in size when they appear singly and become considerably smaller when many of them occur on the same leaf. The æcia are found to be thickly studded on the spots of the upper part of the leaf. The æcia are typical of all rusts of this type, and when mature the spores are liberated by the least wind or touch, forming a yellow powder on the leaf. The spores readily germinate in water, showing that the rust is a heteræcious species. This same observation was also substantiated by Dr. J. C. Arthur, under correspondence dated July 2, 1917. The disease seems to attack the lower leaves first and especially plants which are well developed and on which cotton bolls have attained considerable size. The area of the present infection was found to begin at about four miles west of San Fordyce on the Rio Grande, running east about thirty-five miles and extending north and south about fifteen miles. In the Mission Sharyland district the approximate acres devoted to cotton are about 500, while further East several thousands of acres have been put to cotton this season. There were few patches in that area which were not affected with rust. About two or three miles north of Mission the first outbreak was reported from the ranch of Mr. Charles Brodgen. Soon other ranchmen reported similar outbreaks of cotton rust. The first infection was noticed immediately after a long rainy spell which lasted about three weeks. The rain consisted of short showers, which kept the air very humid. The disease was more serious on older patches and where irrigation was resorted to. Where irrigation and cultivation was slightly neglected infection was found to be very mild. In the same field in those plants which were most protected from either wind or by a top growth infection was heaviest on the lower leaves. Cotton which was planted very close and those plants in the field which made the heaviest growth were also found to be most affected. While infection is confined to the lower leaves, the disease may also be found on the bracts of the bolls. Careful observation so far has not disclosed it on the stem of the cotton plant.

It does not seem probable that this rust has prevailed to any serious extent in the Cotton States before. Some of the oldest cotton growers of Hidalgo County of Texas claim that from their experience of nearly fifty years

with cotton, they have never seen this rust. Many Mexican cotton growers on the Texas border too make similar statements, while one or two others insist that they have seen it before. It seems therefore a puzzle how this rust has escaped the general attention of cotton growers. There is this point which might be of value in considering the source of the present outbreak. The Rio Grande valley receives its irrigation water, not from the Rio Grande, as is commonly supposed, but from the San Juan river and other Mexican rivers. The waters from these rivers empty in a basin or valley in which cotton grows. It is therefore very probable that the waters of the San Juan river have introduced weeds which act as a host to the possible *Puccinia* stage of this rust. It is also probable that the waters of these rivers have carried sporidia from Mexican sources, which were now responsible for the infection of the cotton; all this however is problematical.

Cause.—The disease here reported is a true rust. The æcial stage occurs on the cotton while the *Puccinia* stage undoubtedly occurs on some other host, unknown as yet. In submitting specimens of this cotton rust to Dr. J. C. Arthur, he pronounced it *Æcidium gossypii* E. & E. suggesting also that this rust might come from some grass form, probably *Muhlenbergia,* or *Sporobolus;* Dr. Arthur has specimens of this rust in his herbarium, which was collected by Heald and Wolf at Falfurrias, Texas, September 2, 1909, and two Mexican collections, one from San Jose del Cabos, September 2, 1893, the other from Tlahualilo, collected about 1907, probably by Herrera. Dr. W. A. Orthon[1] states that he has specimens of this rust in his herbarium which were collected in Florida found one year in an experimental plat at Miami. His other specimens came from Falfurrias and other points of the Rio Grande valley, collected seven years ago. From this it is evident that the cotton rust must have been present in Texas and elsewhere, though it did not attract the attention of cotton growers or pathologists. *Æcidium gossypii* E. & E. was first described in *Erythea,* 5:6, 1897. Unfortunately the writer was unable to secure a copy of this publication. There seems no doubt however that the present cotton rust is the same as that which was originally described as *Ascidium gossypii* E. & E. *Uredo gossypii* Lagh. is another but inconspicuous rust which attacks cotton. This is prevalent in Cuba, Porto Rico and southern Florida, twenty-seven collections of which are found in Dr. Arthur's herbarium. It is very likely that the same rust may be found to be more widespread in the cotton states, although it may be easily overlooked because of its inconspicuous nature. *Uredo gossypii* resembles very much any other ordinary *Uredo.*

A careful search of *Æcidium gossypii* in the affected district in Texas has as yet failed to reveal the presence in cotton fields of any grasses belonging to the genus *Muhlenbergia* or *Sporobolus.* On the other hand there are numerous grasses in that locality which are found to be affected by various rusts. More recent investigations have disclosed the fact that there are no new infections found on the cotton since the last outbreak was observed. Moreover the æcidial stage on the previously affected cotton leaves is now found to have dried, leaving no traces of viable spores. The original spots as well as the old cluster cups are overrun by a varied mycological flora. Just what became of the æcidial stage is hard to explain. It is not likely that new infections will start again on the cotton this year. The problem on hand therefore is to determine if possible the alternate host which hibernates the *Puccinia* stage. Drs. Olive and Arthur, as well as the writer, are now working on this phase, and it is hoped that the *Puccinia* stage will be found so that the host which hibernates it will be destroyed, thereby preventing the further spread of cotton rust.

In conclusion the writer wishes to express his indebtedness to Dr. J. C. Arthur for helpful suggestions and for identifications of specimens. Grateful acknowledgments are also due Dr. J. J. Marton, agricultural agent of the Texas State Department of Agriculture, for the hearty cooperation and for information on

[1] Correspondence dated July 25, 1917.

the spread of cotton rust in the Rio Grande valley of Texas.

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SPECIAL ARTICLES

THE EFFECTS OF ACIDS AND SALTS ON "BIO-COLLOIDS"

MIXTURES of agar with gelatine, albumen, protein, urea or amino-acids in which the agar forms seventy-five per cent. or more of the whole, show a similarity of imbibitional behavior to that of sections of plants and hence for convenience in the present studies may be termed *"bio-colloids."* The results of a series of tests with a wide variety of nitrogenous substances from urea to albumen were in general agreement to the effect that such substances mixed in proportions of one to ten, more or less, with agar, when made into thin dried plates, swelled enormously; 2,000 to 3,000 per cent. in distilled water, one half to one tenth this amount in hundredth-molar hydrochloric acid, and more or less in hundredth-molar sodium hydrate.[1]

An extension of the tests of the effects of nitrogenous substances upon the swelling of the amorphous carbohydrates was made to include a mixture of agar and peptone the swelling measurements of which were as follows:

AGAR 90—PEPTONE 10

Water	HCl *M*/100		NaOH *M*/100
3166.6%	500%	(20 hours)	633%
———	566.6	(20 hours)	800
———	633.3	(48 hours)	1,666.6

The chief feature of interest in these results is the uniform swelling in alkali in excess of that in hydrochloric acid, in a manner slightly different to that of similar mixtures in which other nitrogenous substances were used.

[1] See "Growth and Imbibition" presented before the American Philosophical Society, April, 1917, and now in press in the *Transactions* of the society; also "The Behavior of Certain Gels Useful in the Interpretation of the Action of Plants," SCIENCE, 43, p. 484, 1917.

The chief purpose of the entire series of studies has been to ascertain what conditions of growth and development might be identical with the factors affecting imbibition. The fact that plant protoplasts usually consist of a large proportion of carbohydrate gels with a smaller proportion of nitrogenous material has already been discussed. The resulting colloidal mixture may be acidified as a result of certain respiratory processes, or this acid may be broken up as fast as formed, in which case the protoplast might be in a deacidified or neutral condition and from this might vary to alkaline under conditions which we are not yet ready to describe. Acidification and deacidification of the cell may take place at a rapid rate and be complete within a short time, according to the bulk of the cell-mass, temperature and other conditions.

Hydrochloric acid had been used in nearly all of the earlier work for acidification of colloids, since most of the known facts as to the swelling of gels are referable to it. The acids of the plant are organic, and a modification of the technique to heighten the similarity between the experiments and the action of the plant was to substitute citric for hydrochloric acid in the series.

Preliminary to this substitution, series of swellings were carried out to test the relative action of the two acids, with the following results from dried plates of mixtures of 90 parts agar and 10 parts bean protein:

Hydrochloric Acid *M*/100	Citric Acid *M*/100	Sodium Hydrate *M*/100
541.6%	916.6%	916.6%
	875	
	875	
300	402	400

The effect of this organic acid in this initial series of tests was to produce an imbibitional swelling fairly equivalent to that of sodium hydrate and to cause such colloidal mixtures to take up more water than in hydrochloric acid. An extended series of measurements will be necessary before any serious conclusion can be formulated, however.

Another set of factors arising from the presence and concentration of salts is next to

be considered. Certain of these compounds are invariably present, although in varying concentration, and any attempt to apply studies of imbibition to swelling and growth problems must take into consideration the fact that the various reactions due to the presence or proportion of nitrogenous compounds, alkalinity or acidity, invariably ensue in saline solutions, attenuated as they may be in young protoplasts. Tests were therefore planned to determine the action of the common bases and acids on bio-colloids.

Agar which has been used to represent the carbohydrate constituent of living matter gave the following results when dried plates .28 mm. in thickness were tested:

Water	Potassium Nitrate		
	M/100	*M*/50	*M*/10
2,325%.....	1,535.7%	910.7%	607.1%
	Calcium Nitrate		
	785.7	——	500

The amount of swelling as compared with distilled water was decreased by both salts and the inhibiting action increased with the concentration.

A mixture of 90 parts agar and 10 parts of glycocoll gave the following swellings:

Water	Potassium Nitrate		
	M/100	*M*/50	*M*/10
3,266.6%.....	1,800%	1,733.3%	1,333.3%
	Potassium Chloride		
	1,733.3	1,666.6	900
	Calcium Nitrate		
	1,333.3	1,200	800

From which may be seen that an inhibiting effect on imbibition in the bio-colloid similar to that of agar was exerted by these salts, the effect increasing with the concentration and the least swelling taking place in the calcium compounds.

A mixture of 90 parts agar and 10 parts of peptone gave the following swelling measurement.

Water	Potassium Chloride *M*/100	Potassium Chloride, Hydrochloric Acid *M*/100
2076%	1230.8%	500%

Water	Potassium Nitrate		
	M/100	*M*/50	*M*/10
3,166.6%.....	1,600%	1,300%	866.6%
	Calcium Nitrate		
	1,133.3	1,133.3	733.3
	Potassium Chloride		
	1,266.6	——	1,000.0

The lessening or inhibitory effect is seen to increase with the concentration, and less swelling takes place in equivalent calcium solutions than in potassium. The irregularities, however, suggest that peptone mixtures present some special characters which will need further analysis.

Dried plates of a mixture of 90 parts agar and 10 parts urea gave the following swelling measurements:

Water	Potassium Nitrate		
	M/100	*M*/50	*M*/10
2933.3%.....	1533.3%	1233.3%	766.6%
2933.3	1133.3	813.3	700
	Calcium Nitrate		
	813.3	813.3	500

These results are in general accord with those obtained from other nitrogenous mixtures.

A mixture consisting of 10 parts of gelatine and one part of mucilage from *Opuntia* might be considered as equivalent to the colloids consisting of 90 parts gelatine and 10 parts agar, and gave the following swelling measurements.

Water	Potassium Nitrate		
	M/100	*M*/50	*M*/10
589.4%.....	485.5%	455.3%	698.2%
	Potassium Chloride		
	473.2	473.2	401.9
	Calcium Chloride.		
	473.2	.....	348.2

The swelling increases within the range of concentration of potassium nitrate used, and appears to decrease slightly within similar concentrations of potassium chloride, and is checked to a greater extent by calcium chloride, although the last named solution would have a slightly alkaline reaction due to the hydrolysis of the salt.

The effect of salts alone on the bio-colloid in which gelatine forms the nitrogenous constituent is shown by the following measurements of the swelling of a series of dried plates of 90 parts agar and 10 of gelatine, .22 mm. in thickness:

Water	Potassium Nitrate		
	M/100	*M*/50	*M*/10
1,136.4%.....	940.9%	772.7%	613.7%
	Calcium Nitrate		
1,454.5%.....	840.9	704.5	409.1
	Potassium Chloride		
	M/100	*M*/50	*M*/10
	1,000	772.8	590.9
	Calcium Chloride		
	704.5	545.4	386.4
	Sodium Chloride		
	939 (average of 3 tests)		

The next step to be taken was one in which the effect of the universally present salts were tested in various concentrations in connection with conditions of acidity and of deacidity.

As an example of such tests the results obtained by a study of the action of dried plates of a mixture of 90 parts agar and 10 parts bean protein are given below:

Calcium Chloride *M*/100	Calcium Chloride Hydrochloric Acid *M*/100
769.2	538.5

It is apparent from these results that acidity decreases the amount of imbibition in the presence of the salts tested.

A few tests made to determine the limits of imbibition in concentrated solutions revealed the fact that dried plates of 90 parts agar and 10 parts bean protein swelled 576.9 per cent. in a saturated solution of potassium nitrate which has an osmotic coefficient of about 60 atmospheres. The same material swelled 730.9 per cent. in a solution of 50 g. of calcium nitrate in 100 cc. of water (2-molar solution) which has an osmotic coefficient of about 44 atmospheres. A swelling of 100 per cent. was shown in a 3-molar solution of calcium chloride and if hundredth molar hydrochloric acid was added the swelling was increased to as much as 200 per cent. These facts illustrate very forcibly the possibilities of imbibitional absorption against osmotic action. The significance of such action in parasitism and nutritive couples has been discussed elsewhere.[2]

All tests in which the samples of colloid are presented to the action of the reagent in a neutral and dried condition are of course widely different in hydratation conditions from those prevalent in the protoplast. The colloids of the living material are continuously subject to interaction and to modifications resulting from the action of salts, acids, alkalies and their combinations.

A few tests in which plates of bio-colloid swelling from the action of one solution are subjected to another have already been described. The possibilities presented, however, are such as to justify the minutest examination.

In one series dried plates of 90 parts agar and 10 parts bean protein were first subjected to the action of alkali, to hydrochloric acid and to citric acid separately for eighteen hours, at the end of which time their full imbibitional capacity had been reached under the separate influence of each of these reagents. The solutions were then pipetted off and a second reagent introduced. The initial and the secondary action are indicated below.

First Swelling

Hydrochloric Acid *M*/100	Citric Acid *M*/100	Sodium Hydrate *M*/100
300%	402%	400%

2 See MacDougal, D. T., "The Beginning and Physical Basis of Parasitism," *Plant World*, 1917 in press.

A number of tests were made in which the same bio-colloid was successively subjected to a series of reagents with exposures of two hours or more to each one in succession as follows:

Sodium Hydrate $M/100$	Sodium Hydrate $M/100$	Hydrochloric Acid $M/100$
360	300	Slight and irregular shrinkage.

Plates of agar 90 parts gelatine 10 parts, .07 mm. in thickness swelled 1,143 per cent. in 45 minutes in distilled water, then 213 per cent. in $\frac{HCl}{KCl}\frac{M}{100}$ in 2 hours, then 430 per cent. in KCl(M/100) in the next 4 hours, after which it stood in the acidified potassium chloride solution without measurable change for 11 hours. The replacement of this solution by a hundredth molar sodium-hydrate solution was followed by an increased imbibition equivalent to 643 per cent. of the original plate in two hours, at the end of which period it had swelled altogether about 2,400 per cent. of its original thickness.

A similar plate swelled initially 3,357 per cent. in 14 hours in water, then shrank about 300 per cent. in a hundredth molar acidified potassium chloride solution in 11 hours, after which it swelled about the same amount in hundredth molar hydrate.

Some very striking results were obtained by plates .12 mm. thick of 90 parts agar and 10 parts bean protein. A trio of samples swelled 1,416.5 per cent. in 4 hours in distilled water, then shrank 208 per cent. in hundredth molar acidified potassium chloride in 3.5 hours, then swelled 643 per cent. in hundred molar sodium hydrate in 13 hours and 1,250 per cent. in distilled water in 14 hours. At the end of this time a total increase of about a hundred per cent. in hundredth molar hydrochloric acid took place. A second trio of same material swelled about 400 per cent. in less than an hour in water, then 200 per cent. in 3 hours in hundredth molar acidified potassium chloride solution, then 750 per cent. in 3.5 hours in hundredth molar sodium hydrate, 1,583 per cent. in water in 10 hours. After this total imbibition of about 2,500 per cent. had been reached immersion in hundredth molar acidified potassium chloride for 3 hours produced a dehydration of only 167 per cent., not all of which was regained when the acidified salt solution was replaced with water.

These two series serve to illustrate changes in imbibition capacity which might take place in the protoplast. It would be highly unwise to generalize upon the basis of the meager results available, yet the records described suggest certain reasonable assumptions. Among those may be included the inference that after a plate of bio-colloid is in a swelling stage the addition of an acidified salt solution checks the rate of swelling if the total amount is still below that possible in the solution. If the swelling is already beyond the total possible in the acidified salt solution some dehydration occurs, but by no means enough to reduce the swelling to the acidified salt total. Dehydration effects from hydrochloric or citric acid were very slight. The application of alkalies in advanced stages of swelling after acidified salt solutions seemed to increase swelling beyond the total possible in a simple immersion in alkali.

Analyses of modifications of growth rates must therefore take into account not the simple total effect of any solution upon the colloids of the enlarging protoplast, but upon these bodies as already modified by previously acting solutions.

The chief interest in all of the experimentation on imbibition described in this and in previous papers has been directed to various effects simulating growth by acids, alkalies, salts and combinations upon bio-colloids as illustrated by the mixtures described. The differential action which might ensue from the addition or subtraction of a nitrogenous compound from the carbohydrate body of protoplasts in special tracts, changing the imbibition capacity of chromosomes, of spindles or cell plates, etc., may well play an important part in the mechanics of mitosis and cell division.

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H. A. Spoehr,

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June 4, 1917